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Lessons from Embankment Dam Accidents. An Introduction

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SYNOPSIS More than 500 records of embankment dam failures and accidents all over the world,were collected and statistically processed from many points of view. The causes of troubles were classified using a comprehensive scheme. It was found that overtopping is the main cause of failures and of casualities also. Most of troubles affected small earth dams. More than 50% failures and accidents occured during construction or in the first two years of operation. The study is completed with an Appendix containing data on all considered events, this giving the possibility to check up, to correct the possible errors and to bring up to date the statistics.

INTRODUCTION

"The history of dams was a long series of failures" said Pierre Londe, past President of International Commission on Large Dams at a recent meeting (December 1982) of the British section of ICOLD. "It was vital that lessons were learnt from a study of case histories of failures if there were to be better designs in the future".

Every year about one per cent of built dams fails. Although modern dams are much safer than old ones, the problem of safety of dams remains a very important one, as a dam failure usually results in a catastrophe implying considerable loss of property or even lives.

The number of dams built in the world amounts now to approximately 150 000, some 50 000 of them being built in the USA, and this number is continuously increasing. As the greatest part of them are embankment dams, the statistical study of their accidents is very important for further scientific developments.

It is imperious necessary to try to learn from past experience, to use the undesirable events for improving design, construction, and monitoring during operation methods. On the other hand reasons for failure are not usually easily to determine, because of a lack of data or of a very complex concurence of influences of many causes. Failure or accident are not always popularized; sometimes the actual causes or responsabilities are hidden by constructors or even by authorities for different non-technical reasons. So, it is very difficult to draw up a very reliable statistical study of causes of failures and accidents.

According to the writer opinion it is not justified to analyse separately failures and accidents. A near-failure is as much important to be taken into account as an actual failure,from the learning from mistakes point of view.Also,an accident could turn into failure in unfavourable circumstances (darkness during night,day of rest, or similar). Of course, on the other hand,many of considered accidents may be minor, their consideration leading to an inevitable reduction of the study value and reliability. The way of analysing together failures and accidents has been choosen in the present work.

The rightness of available data in technical literature ought also to be accepted. At the same time, the writer many times had to select the main cause among many concurrent ones, or to establish the lesson to be drawn from the analysis. As not always the available data have been complete, this subjective judgement could have been erroneous.

Regarding the number of considered cases, the writer was not able to consult many valuable materials: the ICOLD "Lessons from dam incidents - full report", the ASCE/USCOLD Committee on Failures and Accidents to Large Dams "Lessons from dam incidents", the statistical analysis published by Revista da Universidade, Coimbra (1981), Vogel's"Bibliography of the History of Dam Failures", Data Station for Dam Failures, Vienna (1981), reports of ICOLD Committee on Deterioration of Dam and Reservoirs, and many others. As a consequence, the present study may be substantially improved.

Owing to the fair play and the wish to learn from errors of US technicians, data regarding failures and accidents in USA are more complete and accordingly more representative than for the world over; **for** this reason some of the statistics given in the present work analyses these events only.

Among statistics of dam accidents and their causes, Table I lists the known ones by the writer. In the last line of the table figures corresponding to the present study are also given.

One of the first comprehensive statistical studies of dam failures (published in 1961 by the Spanish publication "Revista de Obras Publicas") found as the most frequent cause foundation failure (40%), followed by inadequate spillway (23%) and poor construction (12%).

TABLE I. Statistics of Dam Accidents (F = failures; A = accidents)

Reference	Numbers of considered events							
	Earth fill		Rock fill		Embankment		All dam types	
	F	A	F	A	F	A	F	A
Revista de Obras Publicas (Gruner, 1963)					177		308	
Post and Londe (1953)					72	-		
Perlea (1973)	278		25		303			
ICOLD (1973)	57	130	7	11	64	141	87	180
USCOLD (Dolcimascolo, 1980)							74	275
Serafim (1981)	88	-	15	-	103	-	146	-
Present study	250	238	23	42	273	280	-	-

Gruner (1963) expressed the opinion that such causes as defects in construction , neglect of maintenance or faulty operation of the outlet works can account for only the minority of the recorded disasters; in the majority of cases, failure occured because the knowledge available at the time of the event proved to be incomplete. Among the major causes of destruction, he mentioned firstly the percolation of water through the dam or its foundation. Post and Londe (1953), analysing the causes of failures of dams in the USA, found that the main cause was overtopping (39%), followed by seepage and underpressure (37%), sliding and settlement (14%). Rather different results have been found by other investigators.

Some of published studies have at least one of the following shortcomings:

- are printed in limitedly used published works (reports of different committees, doctor thesis);
- are analysing together many types of dams, that although having the same function are structurally different;
- do not list the basic data.

The present work represents a brought up to date version of a previous study (Perlea, 1973) based mainly on Babb et al (1968) collection of data. Only accidents related to earth - and rock - fill dams have been selected. Tailing dams were not considered. Cases of deliberate destruction of dams by hostile actions have not been taken into account. Also an accident was not repeated when happend the second time at the same dam, due to the same cause. The considered cases are listed in Appendix, this giving the possibilities: (1) to check up the validity of input data; (2) to correct the undesirable but unavoidable errors; (3) to complete the collected data in order to improve and to bring up to date the study.

KINDS OF ACCIDENTS

To designate the level of dangerousness of an accident, definitions given by ICOLD (1973) have been adopted:

F1 - A major failure involving the complete abandonment of the dam or complete rebuilding.

F2 - A failure which at the time may have been severe, but yet has permitted the extent damage to be successfuly repaired and the (again brought into use.

A1 - An accident to a dam which has been in us(for some time, but which has been prevent(from becoming a failure by immediate remedial measures.

A2 - An accident to a dam which has been obser' during the initial filling of the reservo: and which has been prevented from becomin(failure by immediate remedial measures.

A3 - An accident to a dam during construction, which have been noted before any water w(impounded and where the essential remedia: measures have been carried out and the r(servoir safely filled thereafter.

A4 - Accidents in connection with dams, which · though the dam was not seriously damaged · could have caused a failure if circumstan(had been different or less favourable.

CAUSES OF ACCIDENTS

To classify the causes of failures and acciden(of embankment dams, the scheme in Figure 1 has b(used. This scheme was derived from a simpler o(developed by A.Casagrande (1950). Although los: the advantage of the simplicity of the older o(the proposed scheme is more comprehensive and (easier be used in statistical analysis.

The causes listed in the scheme may be grouped three main categories (ICOLD, 1973), according the probable aspect whose inadequancy represen(the fundamental cause of the unexpected event:

- Stability (causes 1.a and 1.b, eventually 2.(and 3, in the scheme) concerning sliding, st(gth, and total or differential deformation;
- Durability (causes 2 through 6 in Figure 1) (cerning leakage following the degradation o(parts of dam, piping, and liquefaction, as a phenomenon of strength diminishing due to excessive shear deformation or cyclic loading (ring earthquake;
- Function (causes 7.a and 7.b) concerning fl(discharge.

Errors in one or more of the following activiti could have been at the origin of the failure (

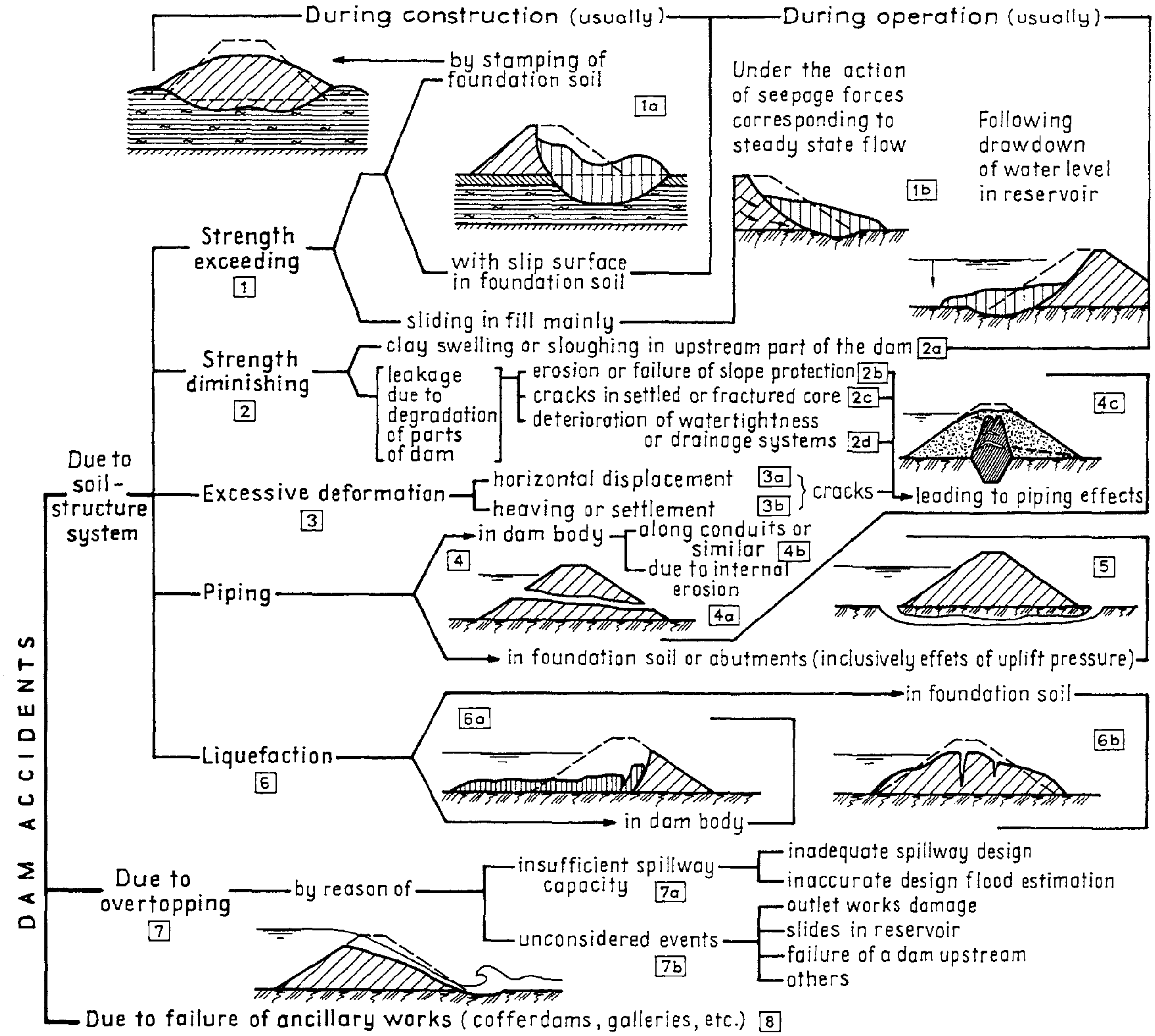


Fig.1. Scheme of causes of embankment dam failures or accidents

of the accident (the initial capital letters were used to designate these cathegories of errors in Figure 3 and Appendix):

- E - Site exploration and field tests;
- M - Laboratory investigation of building material and its choice;
- L - Planning, layout and hydrology;
- D - Design, structural solution and performed analyses;
- C - Construction, methods and quality;
- O - Operation;
- S - Supervision (including instrumentation and its adequate use) and maintenance.

STATISTICS

More than 500 cases of failure and accidents, as listed in Appendix, have been collected. Main data concerning them are presented in the corresponding table: type of dam, with some details when available; height of dam (when the height at the moment of the accident was different from the final or the designed one, the two were recorded); year of completion; year of the trouble, preceded by the code of it, as before specified; probable main cause, using the codification presented in Figure 1; the activities that could have been responsible for the accident or the failure occurring, using initials as aforementioned. Only cases for which the majority of these data has been available (among which the main cause of the trouble necessarily) were kept up in the table.

A simple retrival system with indented cards has been used for data processing. Many kinds of statistical processing have been performed, as it is shown in the following.

RESULTS AND CONCLUSIONS

Figure 2 presents the weight of different causes in producing failures or accidents, separately for dam using as main building material the earth and the rock. It can be seen that the main cause is overtopping both in the case of earth-fill dams (30.5%) and rock-fill dams (32.3%). For dams with earth as main building material the following cause is piping (causes 4 and 5, 29.5%). It follows cause 1, strength exceeding, with 17.6%; here the statistics may be incomplete, as strength exceeding in foundation soil occurs as a rule during construction, when both the designer and the constructor have interest to remedy the trouble without much bustle and popularization.

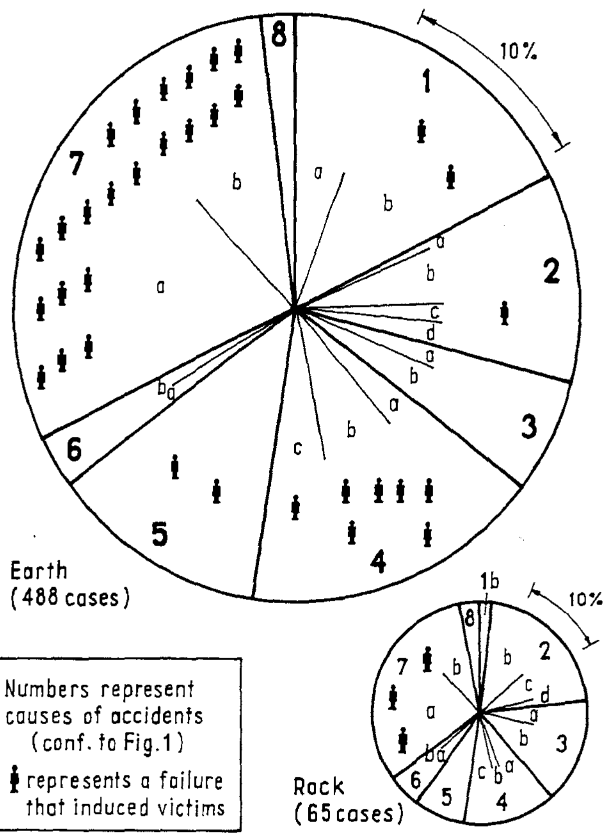


Fig.2. Weight of different causes in producing failures or accidents

In the case of rock-fill dams, accidents by strength exceeding are seldom reported; indeed, they are usually built in locations with favourable foundation conditions, and the building material gives seldom surprise.

Cause 6 (liquefaction) could also have a greater weight then presented in Figure 2. Occurring as a rule during earthquakes, when damages to other types of structure are usually very important, these phenomena are soon forgotten. For instance, in Japan, during Ojika - earthquake in 1939, some 74 embankments with heights ranging between 1.5 and 18.2 m were severely damaged, and 12 failed completely. During Tokachi-Oki earthquake in 1968 also, 49 embankments with heights ranging between 4.6 and 18.2 m were damaged and 10 completely f. led. Although the main cause of these acciden could have been liquefaction, they were not c sidered in the present statistical study for : sons of lack of sufficient data (even the nam embankment was missing).

Figure 2 presents also the number of failures that induced casualities. It can be observed i considered liquefaction cases dit not produce victims. It is also true that, for example, l wer San Fernando Dam liquefaction case was a near - failure, and the margin by which a maj disaster was avoided was extremely small. Acc ding to available data only overtopping and pi ping (inclusively following leakage due to stre diminishing) led to casualities (except two c ses, Necaxa Dam and Valparaiso Dam, which had b designed with too steep slopes and failed rapi

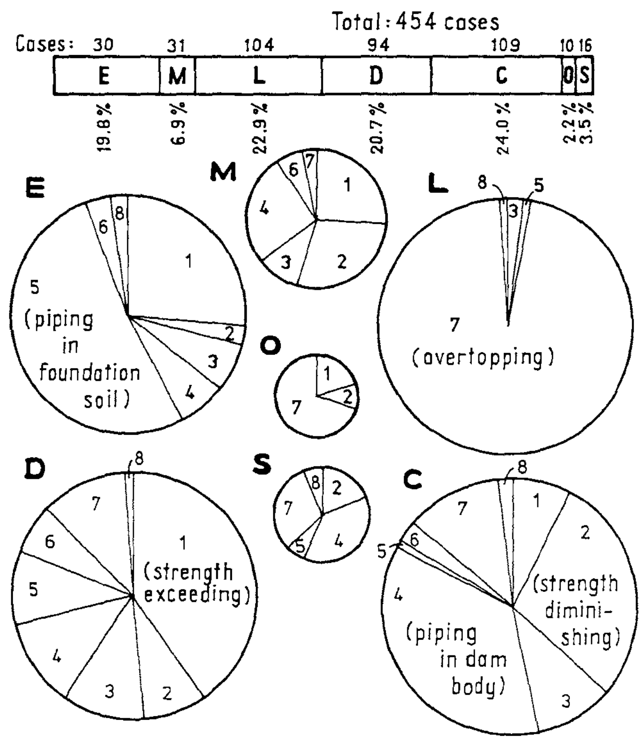
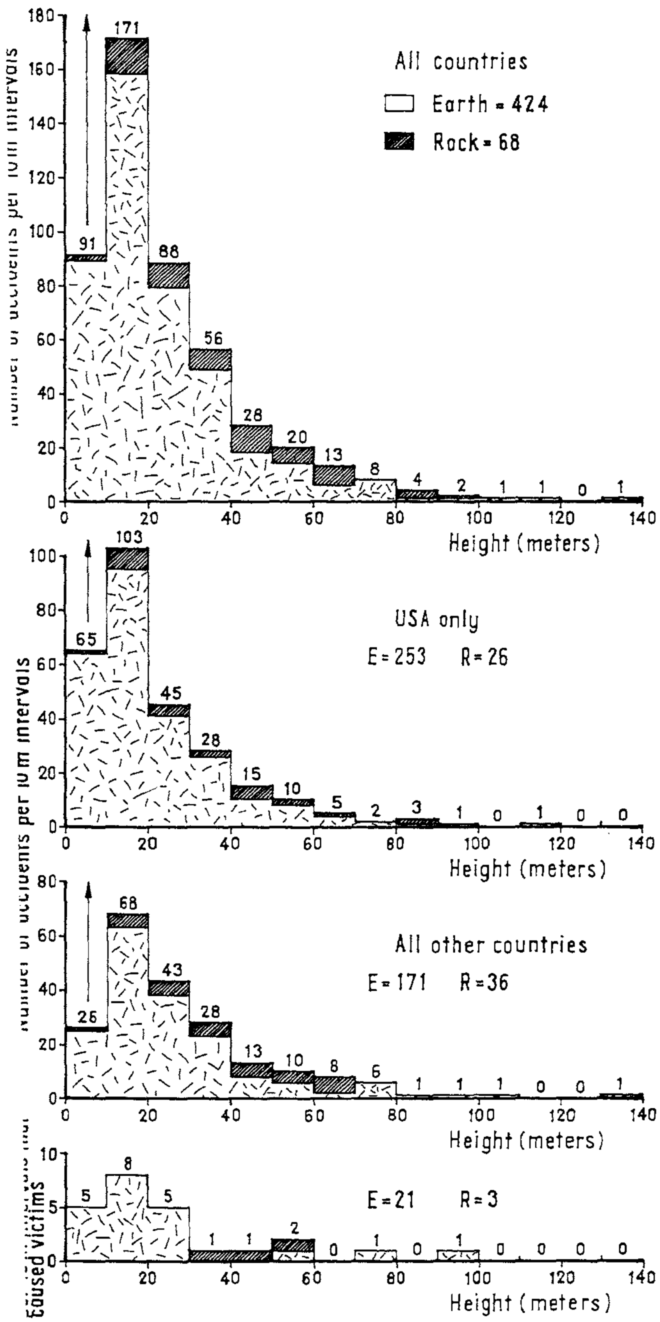


Fig.3. Weight of errors in different human activities in accident producing

It is also interesting to note the important we of hydraulic fill dams among failures by liquefaction in dam body (77.8%) and by strength e ceeding in fill (33.3%).

Figure 3 shows the weight of different activiti which could have been at the accident origin.Tl responsability for analysed troubles producing was sheared between site exploration, hydrologi cal studies, structural design, and constructic of dams.

Errors in site exploration and field tests are responsible especially for accidents and failur by piping in foundation soil. Overtopping is du in the main to insufficient layout and hydro -



.g.4. Number of accidents per heights of dams

;ical studies and to inadequate operation.Poor ;ign led primarily to failures by strength ex- :ding, and poor construction to failures by ·ength diminishing and piping in dam body.

·ure 4 indicates that number of accidents de- ased with height of dams; most of affected by idents dams were less than 30 m in high (54%). number of damaged dams lower than 5 m is su- y greater than in statistics (as indicated by ows on figure) but available data for them incomplete). As data regarding dams in USA more reliable, in that case the weight of est dams is greater (60% lower than 30 m, as

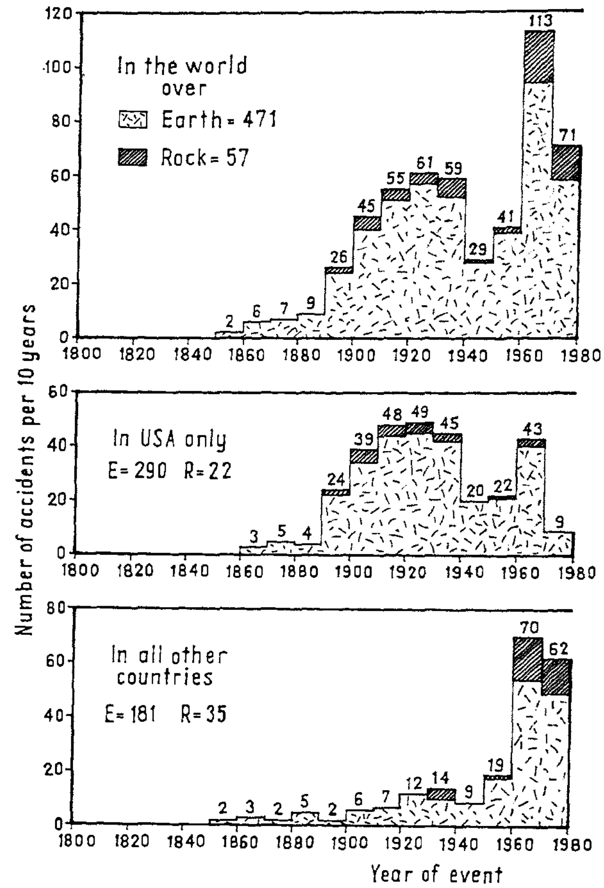


Fig.5. Number of accidents per decade

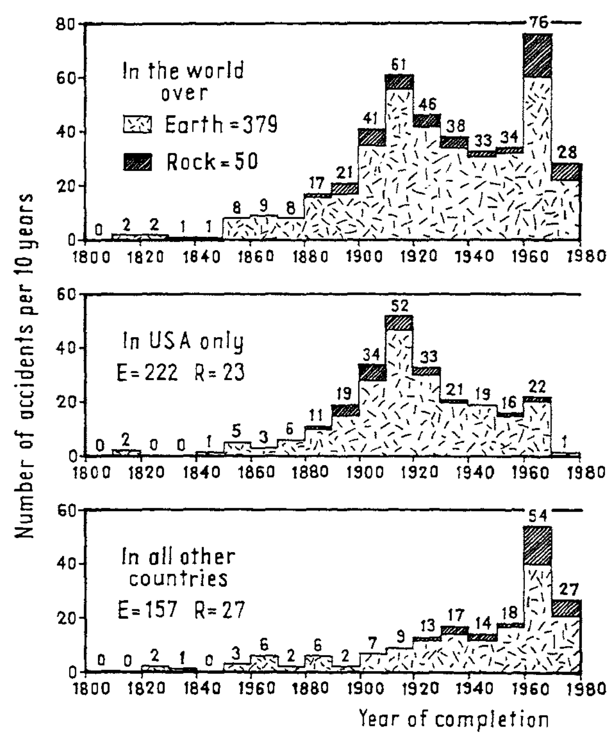


Fig.6. Number of accidents relative to the year of completion

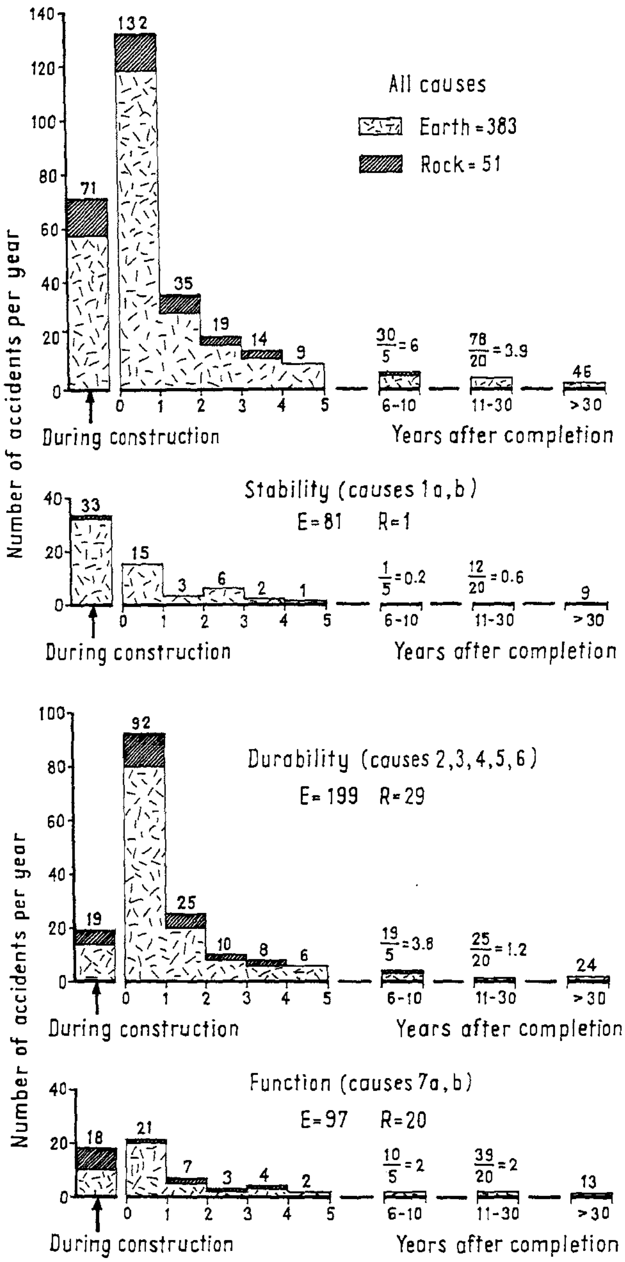


Fig.7. Number of accidents per years of life

against 45% for all other countries). It is possible that the frequence graphs follow proportionally the distribution of existing dams.

From all failures involving victims (according to available informations) 75% corresponds to embankment dams lower than 30 m, and 21% to lower than 5 m ones. So, it is not connection between casualities and height of dam, small dams being as much dangereous as higher ones.

Some other interesting findings result from Figs. 5, 6 and 7. Except for the period before 1900, when the small number of erected dams at the time and the lack of complete informations determine a low number of reported troubles, two periods with large number of accidents can be observe 1920 - 30 and 1960 - 70; the second one is d in the main to other dams than to those in th USA. This finding is more evident in the grap where distribution of accidents was related year of completion of implicated dams. The di rence between the peaks corresponding to dams the USA and in the all other countries is 50 years, this number being a measure of the dif rence in experience regarding dam constructio in the two parts of the world.

Figure 7 shows that dams are much more vulner ble during construction and in the first year ter completion than afterwards. Moreover, pub city associated with accidents during construct is naturally small. Accidents during construc tion are primarily due to inadequacy in stabil aspects (except one case, at earth - fill da only), and in the first year of operation to rability aspects.

In the following only main references have b presented. Among non-listed bibliography are n ny papers published in Proceedings of XIII-th and XIV-th ICOLD Congresses, as well as paper and short notes in International Water Power and Dam Construction.

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PENDIX. Considered Case Histories

Dam	(Country)	Type	H (m)	Compl.	Event	Cause
berton	(Great Britain)	E	17	1940	A3 1937	1a M
ua Vermelha	(Brazil)	E	55	1979	A1 1980	2b D
raura	(India)	E	26	1954	F2 1953	4b
amo Arroyo Site 2	(USA)	E	21	1960	A1 1960	5 D
exander	(USA)	EHY	29/42	1932	A3 1930	6a C
ston No.1	(Great Britain)	E		1932	A3 1927	1b D
ear) Anchorage	(USA)	E	6		F1 1964	3a D
um Fork	(USA)	E	35	1936	A2 1938	5
aconda	(USA)	ECC	22	1898	F1 1938	1b D
derson Weir	(India)	E		1932	A1 1935	5 E
sonia	(USA)	E			F 1894	4b C
a	(Turkey)	EZ	31	1962	A2 1963	2c C
a	(Turkey)	EZ	31	1962	A1 1966	1b D
ishapa	(USA)	ECC	35	1920	F1 1923	4c D
an	(India)	E			F 1978	1a E
bon	(Spain)	REC	32	1967	A1 1975	2c D
m Brook	(USA)	E	18	1963	A1 1964	5 E
rwa	(India)	E	13	1956	A2 1956	4c C
zal	(France)	E	13	1971	F 1968	1a D
hizawa	(Japan)	E	15	1912	F2 1956	7a L
hti	(India)	EZ	18	1883	A1 1885	1b D
bachinskaia	(URSS)	ER	79	1971	A2 1971	4 C
alon (Eddy)	(USA)	RE	12	1890	F1 1893	7a L
alon (Eddy)	(USA)	RE	14	1894	F1 1904	4a S
oca	(USA)	ER	18	1893	F 1894	7a L
bii Yar	(USSR)	E	large		F *1961	7b D
dua	(India)	E	42	1963	A2 1963	3b D
ihe	(China)	RSC	66		A1 1976	6a D
lderhead	(Great Britain)	RECD	48	1965	A1 1967	2c C
ldwin Hills	(USA)	E	80	1951	F1 1963	3b
lsam	(USA)	ECC	18	1927	F1 1929	7a L
rtley	(Great Britain)	E		1931	A3 1927	1b
rton	(USA)	E	12	1922	F2 1922	1b D
ttle River	(Canada)	ECC	14	1956	F2 1956	7b C
ar Gulch	(USA)	E	19	1896	A1 1914	1b D
argamil	(Australia)	E	17	1912	A1 1945	1b D
aver Creek	(USA)	E	small		F 1931	7a L
aver Park	(USA)	R	30	1912	A1 1914	5
lci	(Romania)	EZ	16	1963	A1 1974	8 L
lle Fourche	(USA)	EP	35	1911	A2 1912	2b D
lle Fourche	(USA)	EP	37	1912	A1 1932	1b
lmont	(Great Britain)	E	25	1826	A1 1923	1b
logorsk	(USSR)	EP	26	1965	A2 1966	1a D
namarias	(Spain)	E	14	1972	A2 1973	1b C
la Desna	(Czechoslovakia)	E	17	1915	F1 1916	4a D
shop Creek	(USA)	E	10	1908	F1 1909	7a L
ack Beauty Res.	(USA)	E	15	1951	A2 1951	5 E
ack Rock	(USA)	R	21	1907	F2 1909	5 E
ain Y CWM	(Great Britain)	E	18	1937	A2 1937	2c C
ithfield	(Great Britain)	E	16	1953	A1 1962	7a L
ue Water	(USA)	REC	11	1908	1909	7a L
lan	(Pakistan)	E	19	1961	F 1976	7
laso	(Spain)	E	7	1949	A1 1973	4a M
lton	(USA)	E			F1 1938	7b
n Accord	(South Africa)	E	18	1925	F2 1937	1b O
nshohneken Hill	(USA)	E			A1 1876	1b D
siwick's Pond	(USA)	E	small		F1 1934	7 L
uzey	(France)	E	15		F1*1895	5 E
wman North	(USA)	RCF	53	1927	A1 1928	8
ydstown	(USA)	ETC	9	1896	F1 1897	4b C
adfield	(Great Britain)	EZ	29	1863	F1*1864	4b C
aila-D-Siret	(Romania)	EHO	4	1949	F1 1970	7b
aunig	(USA)	E	27	1962	A2 1963	2b
eak Neck	(USA)	ECC	7	1887	F1 1902	7a L
idle Drift	(South Africa)	RR			F1 1967	2b C
iseis	(Australia)	ERCF	27	1934	F1 1929	7a L
ookville	(USA)	ECC	5	1912	F1 1912	7a L
oomhead	(Great Britain)	E	31	1934	A2 1930	1a E
ush Hollow	(USA)	E	30	1910	A1 1923	8
ush Hollow	(USA)	E	30	1910	A1 1928	1b
ckhorn	(USA)	E			F1 1923	7a L

Dam	(Country)	Type	H (m)	Compl.	Event	Cause
Buena Vista	(USA)	E			A1 1952	3b E
Buhui	(Romania)	E		1908	A1 1957	3b
Bully Creek	(USA)	ECC	38	1913	F1 1925	7 L
Calaveras	(USA)	EHY	57/67	1918	A3 1918	6a M
Calaveras	(USA)	EHY	67	a 1918	F2 1938	2b D
Camden	(USA)	E		1853	1902	7
Camp Ritchie	(USA)	E	8		F1 1929	4a C
Cane Valley	(USA)	R	44	1910	A1	2b C
Carrizal	(Spain)	E	17	1976	A1 1977	2d C
Castlewood	(USA)	R	28	1890	F1 1933	7b C
Catapilco	(Chile)	EHO	14	1910	A1 1971	3b
Cayuga and Seneca C2	(USA)	E		1915	F 1915	2d D
Cethana	(Australia)	RR		a 1968	F 1968	2b C
Charles Lee Tilden P.	(USA)	E	27	1938	A1 1964	7b D
Charmes	(France)	EHO	18	1906	A1 1909	1b D
Cheeseman Lake	(USA)	R	12/64	1900	F1 1900	7a L
Čičov Dyke	(Czechoslovakia)	E	5		F 1965	5 D
Ciriurtsk	(USSR)	E	37		A1	3a D
Clingford	(Great Britain)	E	10	1937	A3 1937	1a E
Clinton No.1	(USA)	E	4		F1 1938	7a L
Clinton No.2	(USA)	ECC	5		F1 1938	7a L
Clogswell	(USA)	R	85		A1 1934	2b C
Cobb Creek Watershed	(USA)	E	23	1959	A2 1959	1a
Cobden	(Canada)	E	11		F 1894	7a L
Coedty	(Great Britain)	ECC	11	1924	F2*1925	7b
Cogoti	(Chile)	RCF	83	1940	A1 1943	3a D
Cogswell (S.Gabriel)	(USA)	R	85	1934	A1 1934	2b C
Cold Springs	(USA)	E	30		A1 1931	2b C
Coleman	(USA)	E			F1 1954	3a
Colley Lake	(USA)	E	19	b 1960	F2 1963	7a L
Colorado Springs R.4	(USA)	EHO	15		A1 1912	4c M
Combs Res.	(Great Britain)	E	16	1826	A1 1976	1b D
Conshohocken Hill	(USA)	EZ			1873	4c C
Corpus Christi	(USA)	E	32	1930	F2 193o	5
Costilla	(USA)	E	37	1920	A1 1924	4c
Cougar	(USA)	R	170	1963	A2 1964	3b C
County	(USA)	E	5		A1 1890	2b C
Cowans Ford	(USA)	E	40	1963	A1 1965	5
Cowlyd	(Great Britain)	E	14	1922	F1 1924	7b L
Crane Creek	(USA)	EZ	19	1920	A1 1928	4b D
Crane Valley	(USA)	R	44	1910	A1	3a C
Credit River	(Canada)	ECC	15	1910	F2 1910	7a L
Cringeni	(Romania)	E	8	1963	F2 1972	7a L
Cuga	(Italy)	RCF	54	1960	A1 1969	3b E
Culimo	(Chile)	EZ	37	1933	A1 1971	3a M
Dale Dyke	(Great Britain)	E	29	1863	F1*1864	4b D
Dallas	(USA)	EP	9		F2 1891	1a E
Dalton	(USA)	ECC	9	1910	1912	5 D
(near) Dartford	(G.Britain)	E	4		F 1953	5 E
Davis	(USA)	EP	12		A2 1914	4b C
Demirkopru	(Turkey)	E	77	1960	A1 1963	2 E
De Sable Forebay	(USA)	E	16	1903	A1 1932	4c
Dhanibara	(India)	EZ	21	1976	F 1976	7a L
Dickinson	(USA)	E	19	1950	A1 1954	7b S
Douhe	(China)	EHO	22		A1 1976	6b
Dry Canion	(USA)	EHY	20	1912	A1 1952	6a
Dry Creek	(USA)	E	11	1938	F 1939	1a E
Dudhava	(India)	E	32	1962	A2 1963	5 E
Duncairn	(Canada)	E	20	1942	A1 1952	7a D
(TK) Dykstra	(USA)	E	15		F1 1926	7a
East Branch (Clarion)	(USA)	EZ	59	1952	A1 1957	4c E
East Liverpool	(USA)	E			A2 1901	4b C
Eildon	(Australia)	ERCD	40	1927	A1 1929	2a D
Eklutna	(USA)	E	6	1929	A1	6
Ekruk	(India)	EZ	27	1871	A1 1973	2a
El Estribon	(Mexico)	E	21	1946	A1 1963	7b M
El Isiro	(Venezuela)	REC	30	1963	A2 1965	3b C
Elk City	(USA)	ECCP	9	1925	F1 1936	7a L
Emery	(USA)	E	15	1850	F 1966	4b S
Empire Reservoir	(USA)	EHO	12	1906	F2 1909	7b
English Water Supply	(USA)	E		1965	A2 1965	5 E
Escanaba No.1	(USA)	E	6	b 1915	F 1930	7a L
Escanaba No.2	(USA)	E	9	b 1915	F 1930	7b

Dam	(Country)	Type	H (m)	Compl.	Event	Cause
Euclides da Cunha	(Brazil)	EHO	56	1960	F1 1977	7b O
Fairview	(USA)	ECC	9		F 1922	5
Flagstaff G.	(Australia)	E	16	1963	A2 1963	5 E
Fontenelle	(USA)	E	42	1964	A2 1965	5 E
Forsythe	(USA)	E	20	1920	A1 1921	5 E
Forsythe	(USA)	E	20	1920	A1 1921	1b O
Fort Jevis	(USA)	E	12	a 1932	A3 1932	1a E
Fort Peck	(USA)	EHY	76	1940	A3 1938	1a E
Fourth Lake	(Canada)	E	22	1960	A2 1961	5 E
Frazier	(USA)	E	8	1915	F 1935	1b D
Frazier Valley	(Canada)	E	4		F 1948	7a L
Fred Burr	(USA)	E	18	1947	F2 1948	1b M
French Landing	(USA)	EP		1925	A2 1925	2d E
Frenchman Creek	(USA)	E	12	1952	1952	7
Fruitgrowers	(USA)	E	11	1898	F 1937	1b D
Gad on Timis	(Romania)	EHO	6		F2 1966	7a L
Garza (Bradford 2)	(USA)	EHY	37	1927	A3 1926	1b M
Gatun	(Panama)	EHY		a 1912	A3 1912	1b M
Giffaumont	(France)	EHO	19	1973	A1 1975	3a M
Gilbert RN2	(USA)	E	15	1913	A2 1913	5 E
Gilbert RN2	(USA)	E	15	1913	A1 1942	7b
Glendevon	(G. Britain)	E	33	1924	A2 1924	2d M
Golder	(USA)	E	40	1964	A2 1964	5 E
Goodrich	(USA)	E	14	1921	F1 1956	4
Goose Creek	(USA)	E	7	1903	F 1916	7
Goose Neck	(USA)	R	21/64	1900	A3 1900	4b C
Graham Lake	(USA)	E	34	1922	F1 1923	5 E
Grand Rapids	(USA)	EZP	7	1874	1900	7 L
Great Western	(USA)	E	19	1907	A1 1958	3b E
Greenbooth	(G. Britain)	E	36	1962	A3 1962	1a D
Green Lick Run	(USA)	E	19	1901	F1 1904	4c C
Gros Ventre	(USA)	E	56	1925	A4 1927	1b D
Guarapiranga	(Brazil)	E	16	1906	A1 1976	7a L
Gunnison	(USA)	E	6		F 1890	4b C
Hamlin Lake	(USA)	ETC	4	1888	F 1912	4
Hans Strydom	(South Afr.)	RSC	57	a 1977	F 1977	7a L
Harlan County)	(USA)	E	31	1952	A1 1956	2b D
Harlem River	(USA)	E	1		F1 1893	7a L
Harrison	(USA)	E	3		F 1931	7b
Harrogate	(Great Britain)	E	9	1869	F 1953	2c M
Hatchtown	(USA)	EZ	12	1900	F1 1900	4b
Hatchtown	(USA)	EZ	19	1908	F1 1914	2d O
Hatfield	(USA)	ECC	15		F1 1911	7b
Hebgen	(USA)	ECC	37	1915	A1 1959	3b
Hebron	(USA)	E	17	1913	F2 1914	5 E
Hebron	(USA)	E	17	1913	F1 1942	7a L
Heiwaike	(Japan)	E	20	1949	F1 1951	7b L
(Lower) Hell Hole	(USA)	R	64/125	a 1965	F2 1964	7a L
Herrin	(USA)	E	12		F1 1935	7
Hollyday Creek	(USA)	E		1901	A3 1901	4c C
Holmes Creek	(USA)	E	20	1903	A1 1924	1b M
(near) Homs	(Syria)	E			A1 1961	7a
Hope Reservoir	(USA)	E	7	1882	F 1907	1b D
Hornell	(USA)	ECC		1912	F2 1912	5 E
Horse Creek No.1	(USA)	E	17	1912	F2 1914	4
Horse Creek No.2	(USA)	E	12		F 1935	7a L
Horton (Mis.Lake)	(USA)	EZP	10	1924	F2 1925	7a L
Hosorogi	(Japan)	E			A1 1948	3a
Hrinova	(Czechoslovakia)	RSC	42	1965	A1 1968	2c M
Hume	(Australia)	E	49	1936	A1 1939	1b D
Hydraulic Co.	(USA)	E		1855	1905	7a L
Hyland	(Australia)	EP	24	1963	A2 1963	7b D
Hyokiri	(Korea)	E			F1*1961	7a L
Hyttejuvet	(Norway)	REC	93	1965	A2 1966	4c M
Ilha Solteira	(Brazil)	ER	75	1967	A4a1969	2b
Insula Brăilei	(Romania)	EHO	4	1964	A2 1965	5
Iron River	(USA)	E			F 1922	7b
Jackson's Bluff	(USA)	E	17	1930	F2 1957	1b D
Jeannette	(USA)	E	6		F1*1903	7a L
Jennings Creek No.3	(USA)	E	21	1962	F2 1963	5 E
Jennings Creek No.5	(USA)	E	20	1962	A1 1962	5 E
Jennings Cr. No.13	(USA)	E	23	1962	A1 1962	5 E
Jesenice	(Czechoslovakia)	E	23	1961	A1 1963	2b D
Jennings Creek No.16	(USA)	E	17	1960	F2 1964	5 E

Dam	(Country)	Type	H (m)	Compl.	Event (
Johnson	(USA)	E	14	1941	F 1945
Julesburg	(USA)	EHO	16	1903	F2 1910
Jupiá	(Brazil)	EP	47	1967	A4 1969
Kaddam	(India)	ER	41	1958	F2 1959
Kaila	(India)	E	26	1955	F2 1965
Kalamba	(India)	EHO	13	1883	A1
Kanopolis	(USA)	E	34	1948	A1 1950
Karachunovskaya	(USSR)	R	22	1950	A3 1934
Kauffman Run	(USA)	EZ	17	1886	A1 1892
Kedar Nala	(India)	F	20	1964	F2 1964
Keene	(USA)	R	5		F1 1895
Kelly Barnes Lake	(USA)	E	9		F1*1978
Kenray	(USA)	E	16	1962	F2 1962
Kern Brothers	(USA)	E	16	1949	F 1949
Ketner	(USA)	ECC	14	1911	F 1911
Ketterling	(Great Britain)	EZ	14	1905	A3 1905
Kharagpur	(India)	E	24	1956	F2 1961
Kingsley	(USA)	EHY	84	1941	A3 1941
Kittanning Point	(USA)	E	15	1876	A1 1894
Konar	(India)	E	38	1955	A1 1963
Koronovo	(Poland)	EHY	24		A1
Kruth Wildenstein	(France)	EP	38	1965	A2 1965
Laanecoorie	(Australia)	EZ	22		F 1909
La Calera	(Mexico)	R	29	1963	A1 1964
Lac Noir	(France)	EHO	15	1932	A1 1948
Lafayette	(USA)	E	37/43	1929	A3 1928
Lagastrello	((Italy)	E	21 b	1914	A3 b1914
Lake Almanor	(USA)	E	40	1927	A2 1928
Lake Barcroft	(USA)	E	21	1913	F 1972
Lake Francis	(USA)	EHY	15	1899	A2 1899
Lake Hemet	(USA)	EZ	7	1923	F2 1927
Lake Lidderdale	(USA)	EHO	6	1907	F 1909
Lake Malloya	(USA)	E	15	1914	A1 1942
Lake Toxaway	(USA)	ER	19	1902	F1 1916
Lake Waco	(USA)	E	21	1930	F2 1947
La Laguna	(Mexico)	E	17	1912	F 1969
Lancaster	(USA)	EZP	9	1894	A2 1894
La Paz Dyke	(Mexico)	E	9		F1*1976
La Regardera	(Columbia)	E	37	1938	F2 1937
Latinu-Desirati	(Romania)	E	3	1973	F2 1975
Latinu-Vadeni	(Romania)	E	3	1952	F2 1970
Latonka	(USA)	EHO	13	1966	F 1966
Lebanon	(USA)	EP	9		F 1882
Lebanon City	(USA)	E	12	1884	F1 1893
Lebanon City	(USA)	E	12	1910	F1 1912
Leroux Creek	(USA)	E	8		F 1905
Lesu	(Romania)	RCF	61	1973	A2 1974
Lima	(USA)	EBC	15	1893	F2 1894
Limoeiro (Armando S)	(Brazil)	ER	35	1958	F 1977
Linville (Lake James)	(USA)	EHY	19/49	1919	A3 1919
Little Deer Creek	(USA)	F	26	1962	F1 1963
Littlefield	(USA)	R	37	1929	F1 1929
Lliu-Lliu	(Chile)	E	20	1917	A1 1971
Loch Alpine	(USA)	EP	8		F 1926
Loerie	(South Africa)	E	21		A1 1977
Long Tom	(USA)	EZ	18	1915	A1 1916
Lookoutshoal	(USA)	E	25	1915	F2 1916
Los Sauces	(Argentina)	RCD	65	1931	A1 1931
Lower Otay	(USA)	RSD	41	1897	F1*1916
Lyman	(USA)	EZ	20	1913	F2 1915
Lynde Brook	(USA)	EP	14	1871	F2 1876
Ljusne Strommar	(Sweden)	E	22	1949	A1 1949
Macherla	(India)	E			F1*1964
Machhu II	(India)	E	16	1973	F1*1979
Madduc Masur	(India)	E	33		F1
Magic Valley	(USA)	E	40	1909	A2 1911
Mammoth	(USA)	EHY	23/38	1914	F1 1917
Manaksagar	(India)	E	16	1962	F *1967
Manivali	(India)	EZ	18	1976	F2 1976
Mansfield S.B.	(Australia)	E	9	1962	A2 1962
Maquoketa	(USA)	E	6	1924	A1 1927
Maraloiu-Sutesti	(Romania)	E	1	1971	F1 1975
Marion County	(USA)	E	17	1938	A2 1938
Lake Francis	(USA)	EHY	23	1902	F2 1935

Dam	(Country)	Type	H (m)	Compl.	Event	Cause
arshall Creek	(USA)	E	25/28	1941	F2 1937	1a E
arshal Lake	(USA)	E	26	1890	A3 1908	4c
arston Lake Dyke	(USA)	E	19	1911	A1 1925	5 E
arte R. Gomez	(Mexico)	E	49	1946	A3 1943	1a E
artin Davey	(USA)	E			F 1940	7
ast	(USA)	E	26	1948	A1 1963	1b D
asterson	(USA)	R	18	1950	A2 1951	3b C
atahina	(New Zealand)	REC	61	1966	A2 1967	4c M
atemale	(France)	EHO	37		A1	2b C
atsuda Tameike	(Japan)	EP	20	1907	A1 1954	7b S
attmark	(Switzerland)	EZ	80/115	a1965	A3 1965	2c C
ay	(Turkey)	E	28	1960	A4 1960	8
ayfield	(USA)	E			A3 1965	2b
c Mahon Gulch	(USA)	E	17	1924	F2 1926	3b L
c Millan	(USA)	EHY	17	1844	A1 1915	4a C
eadow Lake	(USA)	ER	9	1913	F 1962	2b
elville	(USA)	EZ	11	1907	F 1909	4c E
elzingale No.1	(USA)	EBC	9		F 1897	7a L
elzingale No.2	(USA)	EBC	7		F *1897	7b
erril	(USA)	E			F 1912	7 L
essaure	(Sweden)	REC	103		A1	4a M
iddlefield	(USA)	EZ	6	1874	F 1901	7 L
iddle Fork	(USA)	E	24	1939	A2 1940	2d D
iddletown	(USA)	EP	11	1860	F 1961	4 S
ielan	(France)	EHO	16	1968	A1 1971	1b D
ileanca	(Romania)	E	14	1973	A1 1974	5 E
ill Creek (Calif.)	(USA)	E		1899	F 1966	4b E
ill Creek (Wash.)	(USA)	E	44	1941	A2 1941	5 E
ill River	(USA)	ERC	13	1865	F1*1874	2c C
ilton Lake	(USA)	E		1915		1b
inatare	(USA)	ER	35	1915	A1 1920	2b C
iraflores	(Spain)	RBF	40	1976	A2 1976	2b C
ogoto	(South Africa)	E	40	1924	A1 1976	3b C
ohawk	(USA)	E	34	1938	A1 1967	4c
oreana	(USA)	R	51/85	1912	A1 1916	7a O
osrogata	(Great Britain)	E	9	1869	F 1953	2c M
ountain Creek	(USA)	E	11	1931	A2 1931	2d C
ount Lake Park	(USA)	E			F 1938	7 L
ount Pisgah	(USA)	E	23	1910	A1 1928	1b D
urayama Kami	(Japan)	EZP	24	1924	A1 1923	3a L
urayama Shimo	(Japan)	EZ	30	1927	A3 1923	6b E
urola	(Finland)	E	10	1956	A3 1955	1a E
/A	(Venezuela)	E	33	1965	A2 1965	3 M
abataean	(Jordan)	E		100AC	F *1963	7
anaksagar	(India)	E	16	1962	F *1967	5 E
arraguinnep	(USA)	E	30	1910	F 1928	2a M
avajo	(USA)	E	112		A1 1965	8 C
ebaana	(Tunisia)	RE	63	1966	A2 1966	5 E
ecaxa	(Mexico)	EHY	52/59	1909	A3*1909	1b C
ecedah	(USA)	ECC			A 1905	2c C
eraxa	(Mexico)	EHY			F 1909	6a M
etzahualcoyotl	(Mexico)	REC	137		A1 1970	8 S
ew Bedford	(USA)	EZ	8	1866	1868	4b C
ewel Creek	(USA)	ER	66	a 1961	A3 1961	1b
ew Tittesworth	(G.Britain)	E	15	1859	A1 1963	1b D
isipuri-Dedulesti	(Romania)	E	2	1961	A1 1975	7a L
isipuri-Mosesti	(Romania)	E	2	1951	F1 1975	7a L
isipuri-Visani	(Romania)	E	2	1961	F1 1975	7a L
izhne Svirskaya	(USSR)	E	28	1935	F2 1935	7b
izhne Tulomskaya	(USSR)	R	29	1938	A3 1938	1b D
orth Dike	(USA)	E	25	1904	A1 1907	1b D
orth Lake	(USA)	E	6	1904	F 1982	7a L
orth Scituate	(USA)	E	2		F 1926	7 L
beralp	(Switzerland)	E		1962	1965	4 C
choco	(USA)	E	38	1921	A1 1949	4c D
diel	(Spain)	R	35	a 1970	F 1970	7b
gayarindo Tameike	(Japan)	E	19	1944	F2 1963	7b O
jirami	(Nigeria)	E	13		F1 1980	7b O
ld San Andreas	(USA)	E		1875	A1 1906	3a
live Hills	(USA)	ER	40	1962	A2 1963	7b D
no	(Japan)	ECC	49	1913	A1 1923	6b C
rontes	(Syria)	E		b 60AC	F2 1934	4 S
rontes	(Syria)	E		1934	A1 1961	7a
Oros	(Brazil)	EZR	26/54	1962	A3*1960	7b C
Ortotokoyskaya	(USSR)	E	52	1961	A3 1961	4c D
Ortuella	(Spain)	E			F *1964	7a L
Osceola	(USA)	EP	8		A1 1935	8 C
Otaniike	(Japan)	E	27	1920	A1 1946	6b C
Otter Brook	(USA)	ER	41	1958	A3 1957	1b C
Ovcar Banja	(Yugoslavia)	E	27	1952	F2 1965	7a O
Ovoca	(USA)	ECC	5	1901	1914	7
Ower Reservoir	(USA)	E	17/60	1915	F2 1914	4b
Owl Creek	(USA)	E	35		1912	2b S
Oxford	(USA)	E			F 1896	7 L
Pagara	(India)	E	30	1927	F2 1943	7a L
(Main) Paiho	(China)	RSC	66		A1 1976	6b E
Palakmati	(India)	E	15	1942	F 1953	1a E
Pampulha	(Brazil)	E	17	1941	F 1954	2b S
Panciao	(China)	E	25	1951	F1 1975	7a L
Panshet	(India)	EZ	61	1961	F2 1961	7b C
Pardo	(Argentina)	R	15	1940	F1 1969	7b S
Paris	(USA)	ER	17	1939	A3 1939	7a C
Patince	(Czechoslovakia)	EHO	4		F1 1964	5 D
Peapack Brook	(USA)	ECC	10	a 1927	F 1927	7a C
Penn Forest	(USA)	E	52	1959	A2 1960	4c M
Perdiguera	(Spain)	E	11	1882	F 1972	1b D
Piedmont No.1	(USA)	ECC	29	1905	A3 1905	3b E
Piedras	(Spain)	RCF	40	1968	A3 1968	2b C
Pleasant Valley	(USA)	ER	19	1927	A2 1928	4c C
Plopi	(Romania)	E	12	1978	F2 1976	1a E
Poggio Canulli	(Italy)	EZ		1943	A1 1950	6b E
Point of Rocks	(USA)	EP	26	1914	F2 1915	2b D
Poortjie	(South Africa)	E	18	1926	A1 1974	4a
Port Jervis	(USA)	ER	15	1932	A1 1933	5 L
Portland (Maine)	(USA)	EHO	14	1889	F *1893	4b C
Portland (Oregon)	(USA)	EP			A1 1894	2b C
Portneuf	(USA)	E	17		1918	8
Prafleurie	(Switzerland)	E			A1 1962	2b
Prairie Lee Lake	(USA)	E	20	a 1938	A3 1938	5 E
Prairie River	(USA)	E			F 1912	7 L
Pratt Fort Creek	(USA)	E	6	1932	1938	7 L
Prezczyce	(Poland)	EP	14		A1	5 E
Priest Rapids	(USA)	E	56	1959	A1 1964	2 C
Prospect	(Australia)	EZ	26	1889	A3 1888	1a M
Puddingstone	(USA)	EHYP	55	1928	A3 1926	7a C
Puscasi	(Romania)	E	17	1973	A3 1972	8 E
Randall's Pond (Lower)	(USA)	E	5	1816	F 1901	7b L
Randall's Pond (Upper)	(USA)	E	5	1816	F 1901	7a L
Rector Creek	(USA)	EHO	52	1946	A1 1947	3b C
Red Mountain Res.	(USA)	E	18	1949	A2 1950	5 E
Reservoir No.1	(USA)	EP		1959	F 1961	4b C
Reservoir No.4	(USA)	EHO	15		A1 1912	4 D
Rhodesworth	(Great Britain)	E	29	1855	F2 1852	1a E
Riau	(Switzerland)	E			A1 1950	2b
Rio Tinto - Odiel	(Spain)	RBF	35	1970	F 1968	7a L
Riverside Reservoir	(USA)	E	13	1909	A1 1910	2b C
Roberts Pound	(USA)	EZ			F 1922	7b
Rock Cove	(USA)	E	42	1928	1929	4a
Rock Spring	(USA)	E			F 1888	4b C
Rowallan	(Australia)	R	43	1966	A1 1968	4c C
Roxborough	(USA)	E		1893	A2 1894	4a
Roxo	(Portugal)	E	34	1968	A1 1972	4b C
Sabalgarh	(India)	E		1891	A1 1913	4c
Sabetha City Lake	(USA)	E	18	1936	A2 1936	5 D
Sacele	(Romania)	EZ	45	1975	A1 1976	8 E
Saint Lucien	(Algeria)	E	27	1861	F1 1862	5 E
Sallisaw Creek Wat.29	(USA)	E	18	1964	A2 1964	5 E
Saluda (Lake Murray)	(USA)	EHY	59/63	1930	A3 1930	2b C
Sampana Tank	(India)	E	23	1956	A1 1961	1b C
San Andreas	(USA)	EZ	32	1870	A1 1906	3a
Sandaoling	(China)	REC	17		A1 1975	3b
San Fernando (Lower)	(USA)	EHY	43	1930	F1 1971	6a D
San Fernando (Upper)	(USA)	EHY	25	1923	A1 1971	6a D
San Pablo	(USA)	EHY	67	1920	A1 1921	2b
Santee	(USA)	EHY	18	1941	A1 1942	2b C
Santo Amaro	(Brazil)	EHY	19	a 1907	A3 1907	1b M

Dam	(Country)	Type	H(m)	Compl.	Event	Cause
Santo Thomas	(Philippines)	E		a 1976	F *1976	7a C
Sarda Sagar	(India)	EP	16	1961	A2 1963	5 E
Schaeffer	(USA)	ECTC	30	1911	F1 1921	7
Scott Falls	(Canada)	E	15		F2 1923	7 L
Scotts Peak	(Australia)	RBF	43	1972	A1 1976	3b C
Sempor	(Indonesia)	R	53	a 1967	F *1967	7a C
Sepulveda Canyon	(USA)	ECC	20	1914	F1 1914	7a L
Sheep Creek	(USA)	E	18	1969	F 1970	4b C
Sheffield	(USA)	EP	8	1918	F1 1925	6b D
Shell Oil Company	(USA)	E	24	1946	A2 1947	4c
Sherburne (Lower)	(USA)	E		1883	F 1905	7b
Sherburne (Upper)	(USA)	EZ	10	1892	F 1905	7a L
Shimen	(China)	REC	46		A1 1975	6a D
Sidie Hollow	(USA)	E	15	1965	A2 1965	5 E
Simantan	(China)	E	25	1951	F1*1975	7a L
Sinker Creek	(USA)	EHY	21	1921	F1 1943	1b E
Six Mile Creek	(USA)	E	5		F 1905	7a L
Smukala	(Poland)	REC	12			5 D
Snake Ravine	(USA)	EHY	20	1898	F1 1898	1b M
Söse	(Germany)	R	54	1931	A1 1959	7b S
South Fork (Johnstown)	(USA)	ER	22	1852	A2 1862	4b
South Fork (Johnstown)	(USA)	ER	22	1880	F1*1889	7a L
Spartansburg	(USA)	ER	3		F 1892	7 L
Spaulding Pond	(USA)	ER	6	1853	F 1863	4
Spring Lake	(USA)	ER	5		F *1889	4b S
Spuyten Duyvil	(USA)	E	1		F 1893	7a L
Staffordville	(USA)	EP	8		F *1877	4b C
Standley Lake	(USA)	EHY	34	1912	A2 1912	1b C
Steinaker	(USA)	E	43		1962	5 E
Stockton Creek	(USA)	EHOP	29	1950	F2 1950	4c C
Sublette	(USA)	E	16	1915	A1 1937	3b E
Summer Lake	(USA)	E	18	1925	A2 1925	1a E
Surry Mountain	(USA)	E	28	1942	A1 1943	7b
Swansea	(Great Britain)	E	24	1867	F 1879	4a
Swift No.2 (Birch C.)	(USA)	R	48	1914	F1 1964	7a L
Sylvenstein	(Germany)	E	41	1958	A1	2c
Tabia	(Algeria)	E	25	1876	F1 1876	7a L
Table Rock Cove	(USA)	E	43	1927	A1 1928	8 D
Tappan	(USA)	E	18	1936	A3 1934	1a E
Taut	(Romania)	E	22	1971	A3 1970	2d C
Tcharwaksk	(USSR)	REC	168		A3	2c
Tchir-Iurte	(USSR)	EZ	37		A1	3a
Telluride	(USA)	ER	6	1894	F 1909	7a L
Terrace Reservoir	(USA)	EHY	48	1912	F2 1957	4a D
Teton	(USA)	EZ	95	1975	F1*1976	4c C
Throttle	(USA)	E	23		A1 1942	7a L
Tiffin	(USA)	EHO	5		A1 1913	4c
Tittesworth	(Great Britain)	E	31	1962	A3 1962	1b D
Toccoo	(USA)	ER	12	1937	F1*1977	4b
Torcy Vieux	(France)	E	13	1831	A3 1831	1b D
Toreson	(USA)	E	15	1898	F2 1953	4b
Torn River	(USSR)	E			F *1977	7
Toronto	(Canada)	ECC	11		F 1912	7a L
Torre La Vega	(Spain)	E			F *1960	7 L
Torside	(Great Britain)	E	38	1855	F2 1854	1a E
Tous	(Spain)	E	71	1980	F *1982	7b O
Towanda	(USA)	E		1908	1939	1b D
Três Marias	(Brazil)	E	75	1960	A 1961	2b C
Tupper Lake	(USA)	E	5	1906	1906	4b C
Turkey Creek	(USA)	E	18/32	1910	A3 1910	7a C
Two Medicine	(USA)	E	11	1913	F *1964	7a C
Union Bay	(Canada)	ETC	6		F 1912	7a D
Upper Shelton	(USA)	EZ		1881	F 1903	4 S
Upper Tallassee	(USA)	R	19		F 1901	7 L
Valdelafuen	(Spain)	E	7	b 1900	A1 1978	1b D
Valentine	(USA)	E	13	1911	F 1911	3b C
Val Marie	(Canada)	E		1939	A1 1952	7a L
Valparaiso	(Chile)	ER	17		F *1888	1b D
Veeders Pond	(USA)	ETC	9		F 1916	7 L
Victor	(USA)	E	8		1901	7a L
Vidra-Lotru	(Romania)	R	3/118	1973	A4 1970	7b
Vir	(India)	E	54	1961	A1 1962	3b C
Virgin River.	(USA)	R	20/36	1929	1929	7a D
Virsolt	(Romania)	E	14	1977	A1 1978	5
Wachusett North Dyke	(USA)	E	25	1904	F2 1907	1
Waco	(USA)	E	43	1965	A3 1961	1
Wadi Qattarah Lower	(Libya)	E		1975	F 1978	4
Wadi Qattarah Upper	(Libya)	E	32	1974	A1 1978	5
Waghad	(India)	EHO	32	1883	A2 1884	1
Wagner (Loup Loup)	(USA)	EHY	15	1918	F1*1938	7
Wahiawa (Waialua)	(USA)	R	41	1906	F2 1921	7
Walnut Grove	(USA)	R	34	1888	F1*1890	7
Walshaw Dean	(Great Britain)	E	24	1915	A2 1915	5
Walter Bouldin	(USA)	E	50	1967	F 1975	2
Washita	(USA)	ECC	4		F 1914	2
Wassy	(France)	E	16	1883	F 1883	1
Waterloo Lake	(Canada)	REC	20	1961	A2 1962	2
Weisse Desse	(Czechoslovakia)	E	14		F 1916	4
Wesley E. Seale	(USA)	E	35	1958	F2 1965	7
West Branch	(USA)	E	28		A1 1965	3
White Brook (Upper)	(USA)	E	19	1949	A1 1972	4
Willow Creek	(USA)	E	37	1940	A1 1964	3
Wilmington	(USA)	EZP	3	1887	F 1900	4
Winston No.2	(USA)	EBC	8	1904	F 1912	7
Wisconsin Dells	(USA)	R	18	1909	F1 1911	7
Wise River	(USA)	ER			F 1927	7
Wister	(USA)	EHO	30	1948	A2 1949	4
Wolf Creek	(USA)	E	61	1951	A1 1967	5
Woodrat Knob	(USA)	E	26	1956	F2 1961	4
Woodward	(USA)	EHY	20	1918	A1	6
Worms-Mainz-Rhine	(Germany)	E	4		F	4
Worster	(USA)	E	21	1907	A1 1951	4c
Wyandotte County	(USA)	E	28	1941	F2 1937	1
Xonxa	(South Africa)	ERR	48	1974	F2 1972	7a
Yards Creek Upper Res.	(USA)	REC	24	1965	A2 1965	4a
Yate 1	(New Caledonia)	R	12	1925	F1 1933	7a
Yeso	(Chile)	E	60	1960		5
Yorba	(USA)	ER	15	1907	A1 1930	5
Yuba	(USA)	E	8	1948	F 1951	1b
Yuba River	(USA)	EHY			1907	7a
Zigoreni	(Romania)	RCF	29	1973	A1 1977	5
Zimnicea	(Romania)	EHO	4	1958	F1 1965	5
Zoccolo	(Italy)	EHO	67	1965	A2 1976	2d
Zuni	(USA)	EHYR	21	1907	F 1909	5
Zur	(Poland)	EZ	18		A1	5

NOTE. Letters used to designate dam types have t following meanings:
E - earth (rolled, if not hydraulic) fill dams:
EHO - homogeneous; EHY - (full or semi) hydraul fill; EZ - zoned (including dams with puddled cor EP - protected (with concrete, brick, stone or b tumen); EBC - brick core; ECC - concrete core; ERC - rubble core; ETC - timber core; ER - eart and rockfill;
R - rock (or gravel) fill dams:
RE - with earthen upstream slope protection; RC concrete faced; RBF - elastic face (butyle, asphalt); REC - earthen central core; RSC - slopi earth core; RR - reinforced; RCD - reinforced c crete diaphragm; RSD - steel diaphragm.
Preceding year of completion: a - after; b - befo
To designate the event (type and year of accide symbols given in paper have been used; * has bee used when casualities had been reported.
Figures used to designate the causes, are these given in Figure 1. Errors in the following activities could have been at the accident origin: E - exploration of the site; M - investigation and choice of material; L - layout and hydrology D - design; C - construction; O - operation; S - supervision and maintenance.